

THE SCIENCE NEWS-LETTER

A Weekly Summary of Current Science

EDITED BY WATSON DAVIS

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Saturday, December 13, 1924

THE RACE OF THE RARE EARTHS

By Dr. Edwin E. Slosson.

Strongly resembling a Marathon race is a method recently reported by a Columbia professor for separating from each other certain chemical elements that seem to have an inordinate tendency to stick together no matter what the chemist may do to break the family ties.

These elements, sixteen in number, are known collectively as the rare earths. They are really not rare at all, compared to a number of other elements, but while the crude ores were rather easily and cheaply obtained, it required months and in some cases years to isolate the individual members in a pure condition. The consequence is that only in a few instances have scientists had the patience and the interest to carry out these fractionations which consist of from several hundred to as many as fifty thousand repetitions of the same operation. The result is that the rare earths are little known even to chemists, and since almost no pure material has been available for testing, they have found but slight commercial application.

The rare earths are like a family of brothers who have been brought up to be precisely similar in every thought and act. It is impossible to lure one away from the others by any ruse or temptation. Not that they are above temptation, however. The difficulty is that they all yield at once.

But complete identity of individuals is unknown either among the chemical elements or among human beings. The method devised by Prof. James Kendall and Dr. Beverly L. Clarke is based on the fact that if all the brothers are started at same time on a long race, slight individual differences in speed will cause each one to pass the judges' stand at a different moment. If now they are prevented from running back together, a separation is effected.

The apparatus used is a long glass tube provided with electrodes for passing an electric current of fairly high voltage through the contents of the tube. A hot solution is made of salts of the rare earths and to it is added some agar-agar, a substance which causes the liquid to set to a stiff jelly on cooling. This jelly is placed near one end of the glass tube, while on one side is placed a jelly containing an element of a speed slower than any of the rare earths, and on the other side a jelly impregnated with a faster element. The jelly is used simply to prevent the mixing that would occur with liquid solutions. The current when turned on affects the rare earth brothers and the two jailers on either side just as it would affect human beings. It creates a desire in all concerned to move away from there with the highest speed at their command. The faster and slower elements serve to prevent the rare earth section from spreading out, and so the section as a whole moves along the tube and the individual rare earths begin to arrange themselves in a series representing their respective speeds or abilities to get away



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from the electric energy that is urging them on. Provision is made for running the same sample through the tube a large number of times and when a sufficient separation has been obtained, the jelly is removed and quickly sliced into thin sections from which the individual rare earths may be extracted in a pure form.

Up to a few years ago about the only use for the rare earths outside of that of museum curiosities was in the preparation of mantles for obtaining the maximum luminosity from illuminating gas. Thorium and cerium are the metals chiefly used for mantles. With the advent of radio, however, a new use has been found for some members of this family as a coating for the filaments of the vacuum tubes, to enable radio fans to use dry cells instead of storage batteries. It seems highly probable that further research will unearth new and varied fields of employment for these interesting elements, and the new method of separation stands ready to furnish the rare earths in a much purer form, and at a minute fraction of the time and expense formerly required.

Incidentally, the new method is capable of application to other problems than that of the separation of rare earths. Hopes are entertained by its authors that through it will be found a means of purifying certain ores of radium which now practically go to waste, and thus of increasing the supply and lowering the cost of this element that is of so much importance to medicine and pure science alike.

EARLIEST LIFE FORMS MEASURED TWO MILLIONTHS OF AN INCH

Life when it first appeared on this planet was in a form similar to the invisible "filterable viruses" now recognized as the causes of such diseases as hog cholera and leaf mosaic in plants, according to the claim of a Canadian scientist, F. d'Herelle, director of the laboratory of the International Sanitary Council at Alexandria, Egypt, and formerly at the Pasteur Institute, Paris.

These earliest beings had a diameter of twenty millimicrons, or approximately eighteen ten-millionths of an inch -- less than half the shortest wave-length of any visible light ray, and just one-tenth of the diameter of the smallest of known visible bacteria.

Dr. d'Herelle has made his life work the study of the invisible forms of life that lie beyond the reach of the most powerful microscope. Since they can not be seen by any means now known, he has had to study what they do rather than what they look like. He has found that these "viruses" will pass through the walls of the finest filter, and even through an apparently solid sheet of collodion. It was by the latter means that he learned the diameters of the living particles that compose the viruses, for the apparently solid collodion is known to have pores of almost infinite minuteness.

He contends that his tiny creatures, though invisible, are still alive; for they have the properties of all living beings. They feed, they reproduce, they adapt themselves to their environment, by suitable means they can be crippled or killed. They can be divided, according to the effects they produce, into definite species. One form causes a certain fatal disease in poultry and other birds, another causes temperate-zone sleeping sickness, and the several varieties of a third give rise to several varieties of diseases in man and other animals.

One, which is d'Herelle's special pet and private discovery, causes epidemic

in the bacterial world, wiping out disease germs as disease germs wipe out people. This form, known as the Bacteriophage, or "bacterium-devourer", caused a profound sensation when its discovery was announced, and is still the subject of much scientific controversy. Dr. d'Herelle claims, on the basis of this discovery, that health is really as contagious as disease, once the Bacteriophage begins its crusade

All this untramisicropic, ultrafilterable world beyond the reach of sight Dr. D'Herelle has grouped together into a genus which he calls "Protobios", or "primitive life", for he claims that nothing possessing life can be simpler than these creatures. He conceives a "protobe" to consist of a single "micella", or complex group of protein and other molecules.

A further interesting concept of Dr. d'Herelle's is that higher forms of life may be given rise to by the aggregation of micellae, and that at the borderline between protobes and ordinary microbes there are organisms that pass through both forms during their life cycle. He cites two instances to support his case. In one, the culture medium containing one of the lower bacteria was filtered to exclude all of its cells. Yet the filtered liquid, with suitable food elements added, again gave rise to bacteria. In the second, the bacteria of a plant tumor disease were raised from bits of tumorous tissue in which no bacteria could be found by microscopic examination. It is as though a camel, coming to the eye of a needle, could disintegrate into little bits and thus pass through; and the bits again re-assemble into a camel on the other side.

Thus at least does Dr. d'Herelle argue. Micellae endowed with life are protobes; protobes may aggregate into microbes; microbes may differentiate and develop, becoming organized cellular structures like the simpler fungi and the protozoa; unicellular organisms may evolve into multicellular, "higher" plants and animals. The theory is too radical to have been very fully accepted as yet; but it is certainly a bold picture and one to wonder over.

MISSING CHEMICAL ELEMENT LOCATED BY ONE FAINT CLEW

Element 61, one of the five missing chemical building blocks of all matter, may soon be revealed to the world.

Prof. C. J. Lapp of the University of Iowa told the American Physical Society meeting at Ann Arbor, Michigan of his systematic search for this elusive element, which, though not heretofore detected by chemical or physical means, has had many of its properties predicted. Element 61 is known to be a rare earth, in the same class with cerium, whose oxides are used in the manufacture of gas mantles. There is a vacant space in the periodic table of chemical elements between number 60, neodymium, and 62, samarium, waiting to be filled.

One faint clew to missing element 61 has been found by Prof. Lapp. By examining some samples of rare earths carefully prepared by his colleague, B. S. Hopkins, he has discovered a single and very faint line in the spectrum produced by X-rays reflected onto a photographic plate from the rare earth sample. This line is not claimed by any other chemical element and corresponds very closely in wavelength to a line predicted on theoretical considerations as belonging to element 61. On this evidence, Prof. Lapp believes it likely that element 61 is present in his samples of rare earths in quantities of about 1 part in 2000 or less.

Even if later research results in the definite identification of element 61 and its chemical isolation, it is doubtful if it will be of any commercial value.

It is a well-known fact that the American Medical Association has been the leading organization in the United States for the advancement of the medical profession. It has been the champion of the physician's rights and the defender of the public health. Its efforts have been directed towards the improvement of the medical education of the physician, the advancement of the medical science, and the betterment of the medical practice.

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Very few of the rare earths are utilized in everyday life and they are usually so mixed up one with the other that they are only occasionally separated with any degree of purity. The rare earths include such unfamiliar elements as: cerium, praeodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, cassiopeium.

There are now only five missing chemical elements, including number 61. All the rest of the 92 elements, from the lightest, hydrogen, to the heaviest, uranium, have been discovered. Numbers 43, 75, 85, and 87 are among the missing.

Many of the chemical elements have been first discovered in the spectrum and then found and isolated by chemical means. Helium was discovered in the sun in 1868 by lines seen in the spectrum of sunlight and not until 1895 was it isolated by Sir William Ramsay. The latest conquest of physics and chemistry was the discovery of element 72, hafnium, by the Dutch physicist Coster and the Hungarian chemist Hevesy working in the laboratory of Prof. Niels Bohr in Copenhagen. Using first the X-ray spectroscope and then chemical methods, they discovered that hafnium frequently occurs in zirconium minerals and makes up about one two-hundred-thousandth of the earth's crust. It is more plentiful than the well known metal, tungsten. The periodic table of elements, devised by the Russian chemist, Mendeleeff in 1869, arranged the elements in logical order and allowed prediction of some of those then missing. Moseley, the young British physicist who was killed early in the world war, was able by applying X-ray spectroscopic methods to arrange the known chemical elements in an orderly series according to their atomic numbers. This classification is more enlightening than the Mendeleeff periodic table and has allowed more precise prediction of the properties of missing elements.

COMET'S TAIL DUPLICATED IN PHYSICS LABORATORY

Duplicating a comet's tail in the laboratory is the accomplishment of Prof. Harvey B. Lemon of the University of Chicago.

Certain comets having irregular tails show band spectra in the spectroscopes here on earth that are due to compounds of carbon never seen elsewhere in celestial objects. Prof. Lemon by mixing helium gas and gases from activated carbon, under very low pressure, has been able to reproduce the comet tail spectra with great brilliance, thus showing that he has been able to duplicate in part the conditions in a comet's tail.

CLAIMS RESINS WERE ORIGIN OF DIAMONDS

Similarity between the X-ray pictures of the lattice structure of diamond crystals and of decaterpene, a resinous substance, is the basis for the claim advanced by Herr Decker, a Jena chemist, that diamonds originated from this material under enormous pressure and possibly heat, during long periods of time, according to the Berlin correspondent of Industrial and Engineering Chemistry.

Diamonds have long been known to be pure carbon in crystalline form, but what the original carbonaceous material was out of which they developed has been a subject of dispute. Resins contain hydrogen as well as carbon, and the theory of the German scientist assumes that under the conditions of diamond formation the hydrogen was literally slowly squeezed out of the raw material until at last nothing but pure crystalline carbon was left.

VOLCANO TO SPEAK OVER THE RADIO

The roar of next eruption of the volcano Etna will be heard all over Europe, and possibly America as well, if the new radio station established on the rim of its crater functions properly. Signor G. Marconi, the pioneer of wireless communication, has erected a 300 foot tower to bear the antenna, and is waiting for the volcano to break its silence.

ODOR OF CARNATION RESTORED IN ENGLAND

Some remarkable new flowers were introduced at the autumn show of the Royal Horticultural Society in London.

One gladiolus produced in Scotland contained a single spike with 17 orange scarlet blossoms and about a dozen buds ready to open. Another novelty was a mammoth salmon-pink chrysanthemum.

Perhaps the most valuable new offering was a heliotrope and rose carnation which can be made to flower outdoors for six months, or until a severe frost.

This flower has recovered the famous musk perfume of early carnations which has been largely lost with the intensive development of the flowers.

The gladiolus exhibit was especially remarkable. Some gladioli were brought from Germany by airplane especially for the exhibit.

SCOTCH BOTANIST FINDS NEW WAY TO GROW PLANTS FROM CUTTINGS

Plants that do not readily grow from cuttings may be made to do so by a very simple trick discovered by L. B. Stewart at the Royal Botanic Garden in Edinburgh.

Growing plants from cuttings is a time-honored method with soft-stemmed plants, and with woody stems that are not too hard and slow-growing, like grape and poplar. But certain trees of slow growth, like camphor, have always been difficult to get started.

Mr. Stewart shaded branches of camphor trees, and induced them to put forth "etiolated" twigs, that is, long, slim, sappy shoots like those produced by plants kept in a dark cellar. These soft, fast-growing shoots strike root much more readily than do cuttings taken from the harder, more mature twigs of the naturally grown plant.

ESKIMOS QUIT IGLOOS; BUILD BRICK HOUSES

Natives living in northern Alaska beyond the Arctic circle are turning from the snow igloos and dugouts to houses built of lumber and brick. Capt. John Worth, master of the Carolyn Frances, from Seattle, first visited the Bethel and Kuskokwim river districts in 1904, in quest of furs, gold and ivory. Then the Eskimos and Indians lived in almost primitive style. This year he again went north

The first of the three main points of the report is that the economy of the country is in a state of depression. This is due to a number of factors, including a fall in the price of the main export, a decline in the volume of foreign trade, and a reduction in the amount of government expenditure. The second point is that the government has taken a number of measures to deal with the situation, including a reduction in the price of the main export, a decline in the volume of foreign trade, and a reduction in the amount of government expenditure. The third point is that the government has taken a number of measures to deal with the situation, including a reduction in the price of the main export, a decline in the volume of foreign trade, and a reduction in the amount of government expenditure.

THE ECONOMIC SITUATION IN 1960

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THE ECONOMIC SITUATION IN 1961

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on a trading mission and found all changed. The natives have become interested in reindeer herding, fur farming and goldmining; and following the white man's ways are content in modern houses, so far as possible in that isolated country.

AIR IS BLUE, PHYSICIST DISCOVERS

Air is a blue-colored gas, according to recent investigations of Dr. C. B. Raman, noted Hindu physicist of the University of Calcutta. Dr. Raman is taking advantage of the brilliant sunlight of Pasadena for a year of research at the California Institute of Technology.

Classic school-books have always said that air is a colorless gas. To this Dr. Raman counters - "Look up at the sky." The advice is simple, although the obvious deduction from it has not been accepted in the past. In fact the blue color of the heavens has been attributed in recent publications to intensely cold nitrogen crystals in high altitudes. This ingenious theory is discredited by Dr. Raman as fanciful and at best entirely unproven and unnecessary.

Air-layers of ordinary thickness, "such as one views within short distances do not reflect enough of the blue light to give a blue reaction on the retina of the eye. Dust and moisture confuse the results in most cases, anyway. For exact observation, two plans logically follow. One is to examine a layer of clean dry air many miles thick, i.e., to behold the sky. When the test is made at high altitudes, the atmosphere overhead becomes too thin to exhibit the full blue color of the air, and the sky becomes blue-black, a color which merely indicates lack of reflection. Such an observation does not substantiate the frozen nitrogen crystal theory.

The second plan of observation, which is the basis of Dr. Raman's experiments at Calcutta, is to admit a highly concentrated beam of tropical sunlight into purified air in an intensely dark room. The experimenter has dubbed his dark chamber the "black hole of Calcutta." It requires a half-hour for the human eye to become thoroughly accustomed to the Stygian darkness of the "hole" before the blue color of the air can be observed.

The apparent absence of color in ordinary air is explained as easily as the case where one drop of blue ink is stirred into a barrel of water. The air is diluted in space instead of water, and weighs less than a fiftieth of an ounce per gallon even at levels of high density.

The experiments of the Hindu physicist are conducted for the purpose of determining the form and structure of gaseous molecules. Success in the investigation will mean that a chemist may check his ideas of structure of drugs, dyes, etc., by the type of light waves which are reflected from the molecules.

Japan is the third largest machinery market in the world.

Heart disease is the greatest single cause of death in the United States.

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MEMBERS OF THE ROYAL SOCIETY, LONDON, 1891.

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EUROPEAN CHEMIST FINDS SUBSTITUTE FOR PLATINUM

Platinum laboratory vessels, indispensable in certain chemical operations, have become very expensive, due partly to the increased use of platinum jewelry and partly to the virtual cutting off of the Russian supply, formerly the principal source of the metal. Dr. A. Gawalowski, an Austrian chemist, reports the successful use of vessels made of an alloy of silver and aluminum, thinly coated with platinum by an interesting process. The alloy was dusted over with "platinum black" a microscopically fine dust of platinum, and then hammered, or rolled under heavy pressure. This peculiar method of plating gave the alloy sufficient protection against the strong acids and alkalis of the chemical laboratory.

BEES "SAY IT WITH DANCING", GERMAN SCIENTIST DISCOVERS

That bees have a means of communicating with each other, and that this means consists mainly of a sort of rhythmic dance, supplemented by a language of odors, are the discoveries announced in Berlin, by Prof. Karl von Frisch, who has devoted twelve years to the study of these interesting insects.

Prof. Frisch used a special glass-sided hive which permitted close observation of his bees. He marked certain individuals with colored spots, to make it easy for him to tell them in a crowd. He found that when a worker has found a good source of honey, it executes a sort of wild war dance upon its return to the hive, attracting the attention of its fellow-workers. The dancing bee carries the odor of the blossoms which it has visited, and is diligently sniffed at by the others, which thus know what flowers to look for.

The bee marks its discovery by emptying the contents of a special gland, which leaves a strong odor on the spot, to guide its companions in their search.

Prof. Frisch has also studied the color-vision of bees. By baiting colored strips of paper with honey, he "educated" bees to certain colors. Bees can see all the colors in the spectrum above the orange-red, but they are blind to red and react to it as though it were black. But their vision ranges above that of the human eye at the upper end of the spectrum; they are able to see ultra-violet light, which is invisible to man. They have a good sense of smell, but not better, Prof. Frisch believes, than that of man.

BILLIONS OF DIRT PARTICLES ENTER LUNGS

The Londoner inhales on a day of heavy smoke fog about 500 billion particles of dirt, which placed end to end would form a line about 250 miles long, according to experiments conducted by the British meteorological bureau. From 20,000 to 50,000 particles are present in each cubic centimeter of London air.

Only when considered in the mass are these particles of foreign matter in the atmosphere likely to excite alarm. They are very minute. It requires about 10,000 of them per cubic centimeter to make a milligram of dirt in a cubic meter.

The results of the London experiments are announced in connection with the annual report of the Advisory Committee on Atmospheric pollution named in 1922 as a result of agitation by the Coal Smoke Abatement Society.

The dust particles are counted by a device known as the jet dust counter. These have been installed at the meteorological offices of the principal world capitals. By this device fifty cubic centimeters of air are pushed rapidly through a slit and the dust deposited on a cover glass of small cross section to be examined microscopically.

Two other instruments for use in such investigations have been perfected:-

1. A standard gauge measuring the total impurities in a month over a measured area. The total is analyzed into insoluble and soluble, tar and other carbonaceous matter and ordinary, wind-borne, inorganic dust.

2. An automatic filter which isolates samples of impurities near the edge of a circular disk of filter paper at intervals of two hours or more.

Some progress has been made, the committee reports, in investigating the relation between transparency or visibility and the amount and nature of the impurity in the atmosphere. Two methods of measuring transparency have been evolved. In the first a uniformly illuminated surface has its optical brightness measured with an ordinary photometer at different distances. In the second a specially designed photometer is placed in the beam of a searchlight and a comparison made of the illumination of the mirror with that of a black stop placed in front. By this device changes in the transparency of the atmosphere which continually are occurring can be detected and measured. At the same time observations by filter and dust counter can be made so that a good idea is obtained of the efficiency of the dust and other particles in diminishing transparency.

Little is known as yet, however, on the relation between water droplets which form the bulk of the obstruction of clouds and the hygroscopic dust particles which are so necessary in the formation of clouds. An interesting observation is that records obtained from tobacco smoke show only a transparent, yellow, oily deposit, free from solid particles.

Impurities in the air are at their maximum between 10 a.m. and 6 p.m. Between midnight and 6 a.m. there is comparative purity.

YELLOWSTONE PARK ELK HAS LARGE HAREM

An elk of most decided polygamous tendencies was reported by Yellowstone Park Naturalist, E. J. Sawyer upon his return from a recent trip into the deeper fastnesses of the park. He saw and followed a herd of sixty-six animals, which proved to be under the dominance of a single bull.

"He was a magnificent animal", related Mr. Sawyer. "He had a large, wide-spreading set of antlers and he kept always in the rear. Following this herd, keeping directly behind it, at distances varying from 100 to 300 or 400 feet, was another large bull elk. For the most part he kept his nose to the ground as a dog does in following a scent, but at short intervals he raised his head and bugled. He was not allowed to approach the herd more closely, for whenever he came within a distance of about 100 feet the bull from the herd turned and made a running charge before which the other always retreated while a safe distance still remained between them. The closely massed herd of cows looking on with passive interest, the fog shutting out more distant features of the landscape while throwing the great animals into strong relief - all contributed to make of this wild life scene a thrilling, impressive and memorable picture."

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BIRDS WAGE WAR ON BOLL WEEVIL

Winter tourists from the North destroy the boll weevil and white grub, two deadly enemies of the southern cotton crop, and should, therefore, be protected by the farmers. The common pipit, a bird that goes south during the winter months, prizes the weevil and the grub as choice bits of his diet.

He is, moreover, the only species of winter bird that is an active help to the farmer. Regardless of traditions, the U. S. Department of Agriculture has proved that other winter birds and neither a help nor a hindrance to the farmers.

The stomachs of snow buntings and long spurs, common winter birds, show that their diet consists almost entirely of weed seeds. While this is a step in the direction of help they cannot eat enough to be of any material value. The birds are, however, vindicated of the charge of eating fresh, green buds.

DESTRUCTIVE MONTANA WOLVES HAVE CANINE ANCESTORS

A story reminiscent of Jack London's "Call of the Wild", but in grim earnest and without romance, has come to the Bureau of Biological Survey of the U. S. Department of Agriculture.

Last winter a number of wolves, including three black ones, were reported by different stockmen east of Lodgegrass in the Wolf Mountains in Montana. A government hunter, assigned to clear them out, trapped an almost black animal that was obviously part dog, and a short time afterwards, in the same vicinity, he killed a vicious wild dog similar to an Airedale, probably the sire of the half-blood. It is believed that most of the wolves in this pack are half-breeds.

YELLOWSTONE PARK BISON JOIN CALIFORNIA MOVIES

Sixteen of the 86 surplus blison that were subtracted from the Yellowstone Park herd this season have gone to California to join the movies. The Yellowstone bison have often been filmed on their native heath, and during the present season performed a leading role in the production of the Famous Players-Lasky film, "The Thundering Herd". The contingent now bound for Hollywood will be active in completing this feature. When this has been completed they will be released on Catalina Island.

The animals sent out from the Park went to municipalities for the most part, but some went to game preserves and forests, and a few to private estates. The largest pair shipped went to Flo Ziegfield.

The bison herd in Yellowstone Park started in 1902, with 21 animals, 13 cows from the Allard herd of Western Montana and three bulls from the Goodnight herd of Texas. They multiply very rapidly, and the herd numbered 780 on August 1. There were 120 calves this spring, and 100 in the spring of 1923.

Fish oils may be freed from their disagreeable odor by scrubbing them with an inert gas.

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LARGE BRAIN OF HUMANS RESULT OF IDLE INFANCY

That the large brain of the human species is due to the long period of helpless and idle infancy, during which the brain works very little and can spend all its time multiplying cells and growing, is the theory of Dr. Emil Devaux, a French army physician.

Dr. Devaux points out that during the first three years of a child's life its head grows to practically full adult size, and that the most rapid growth takes place during the first year. During this time the child sleeps a great deal and neither walks nor talks. It lives on liquid food, which needs only to be swallowed, and does not require the complex effort and energy expenditure of chewing. With little to occupy it the brain is an idle organ and can vegetate freely.

The lower animals suffer the disadvantage of being able to look out for themselves at an earlier age, many of them from the moment they are born or are hatched from the egg. This takes the time of infantile leisure away from the brain and stops its growth.

As a corollary to his theory, Dr. Devaux holds that it is a mistake for parents to encourage babies into precocious activity. He claims that forcing the brain to function before its natural time has the effect of stunting its growth.

NEW APOCRYPHAL BOOKS BEING TRANSLATED

The University of Louvain and the Catholic University of America are cooperating to translate into French and English all the apocryphal books of the New Testament which have been discovered to date. A number of these, discovered within the last few years in Coptic and Abyssinian monasteries, exist only in the languages of those countries.

Although rejected as spurious gospel, written for the most part in the third and fourth centuries after the Crucifixion, these books are expected to contain a large amount of valuable literature which will be made available to the reading public for the first time.

TABLOID BOOK REVIEW

THE ATOM AND THE BOHR THEORY OF ITS STRUCTURE: By H. A. Kramers and H. Holst with a foreword by Sir Ernest Rutherford, Gyldeudal, London. 10/6 net.

Written by two associates of Prof. Niels Bohr, the Danish physicist who has explained so much of the internal workings of the atom, this book is authoritative. In addition it is readable. It explains the Bohr theory in a way that only those who understand thoroughly can do. The essential ideas are explained without mathematical calculations, for which the general reader will offer up praise.

Weevils are spread in crops not by planting infected seeds but from the crop that has been held over from the preceding year and stored near the fields.